Towards Flexible Mobile Data Collection in Healthcare

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***Abstract*—The widespread dissemination of smart mobile devices offers promising perspectives for a variety of healthcare data collection scenarios. Usually, the implementation of mobile healthcare applications for collecting patient data is cumbersome and time-consuming due to scenario-specific requirements as well as continuous adaptations to already existing mobile applications. Emerging approaches, therefore, aim to empower domain experts to create mobile data collection applications themselves. This paper discusses flexibility issues considered by a generic and sophisticated framework for realizing mobile data collection applications. Thereby, flexibility is discussed along different phases of data collection scenarios. Altogether, the realized flexibility significantly increases the practical benefit of smart mobile devices in healthcare data collection scenarios.**

***Keywords*-Mobile Data Collection, Process-driven Data Collection, Data Collection Flexibility.**

I. Introduction

Using smart mobile devices (e.g., tablets and smartphones) in healthcare scenarios has become increasingly important during the last years. To overcome the drawbacks of traditional paper-based instruments (e.g., questionnaires), mobile applications specifically tailored to a particular healthcare scenario shall enable experts from various domains (e.g., healthcare or psychology) to collect patient data more effectively. Based on the experiences gathered in various projects realizing mobile data collection applications in the large scale, a number of crucial requirements has been identified. For example, sophisticated operations[1] for navigating within user forms were often demanded. In this context, a flexible customization of the user interface was crucial, ranging from issues related to multilingualism up to individual control elements not introduced before[2].

The mentioned projects further revealed that mobile data collection applications frequently need to be adapted to changing requirements. For example, changes became necessary due to the rapid development cycles of mobile operating systems (i.e., Android) and emerging demands for new features (e.g., integrating questionnaires with sensors to measure and record vital parameters of the patients). In this context, IT experts needed to be involved to properly address these requirements, resulting in a cost explosion in most projects. What domain experts actually demanded, however, are tools enabling them to create sophisticated mobile data collection applications themselves. For this purpose, a comprehensive technology framework has been developed, which supports the *design*, *deployment* and *execution* of mobile data collection applications as well as the *analysis* and *archiving* of the data collected. In particular, the framework enables customizable mobile applications by allowing for flexible adaptations of the mobile data collection application during all these phases. Note that this flexibility reduces development costs significantly, while at the same time it improves the time to deliver a respective mobile application. This paper envisions how the developed framework supports flexible adaptations in healthcare data collection scenarios.

Section II introduces technologies enabling flexibility in mobile data collection projects. Section III discusses related work and Section IV concludes the paper.

[1]Skip questions depending on already given answers.

[2]Psychological questionnaires may need a neutral position for certain controls (e.g., slider) not influencing the participant in any way.

II. Flexibility Goals

When realizing mobile data collection applications, flexibility issues are considered for three phases (cf. Fig. 1):

(1) Design Time. Flexibility is provided through an advanced configurator component and end-user programming. The configurator allows creating all elements needed to design a data collection instrument (e.g., texts or questions). The latter may be provided in different languages to enable multilingualism. Through a model-based approach domain experts are enabled to easily define the logic and structure of the data collection instrument themselves. Advanced wizards guide domain experts through the process of defining navigation paths for instruments. Finally, sensors for collecting data during run time are modeled on an abstract level.

(2) Deployment Time. The designed data collection instrument is mapped to a process model [1] and is installed on respective smart mobile devices. Process management technology, in turn, is utilized to ensure a flexible and robust execution of the process instance during data collection.

(3) Run Time flexibility requires the consideration of several issues. First, a (lightweight) process engine for the robust execution of the process model defining the logic of the instrument is run on the smart mobile device. This engine is capable of enacting and interpreting the underlying process model. The logic to be executed during one specific process node (e.g., displaying a form or retrieving data from

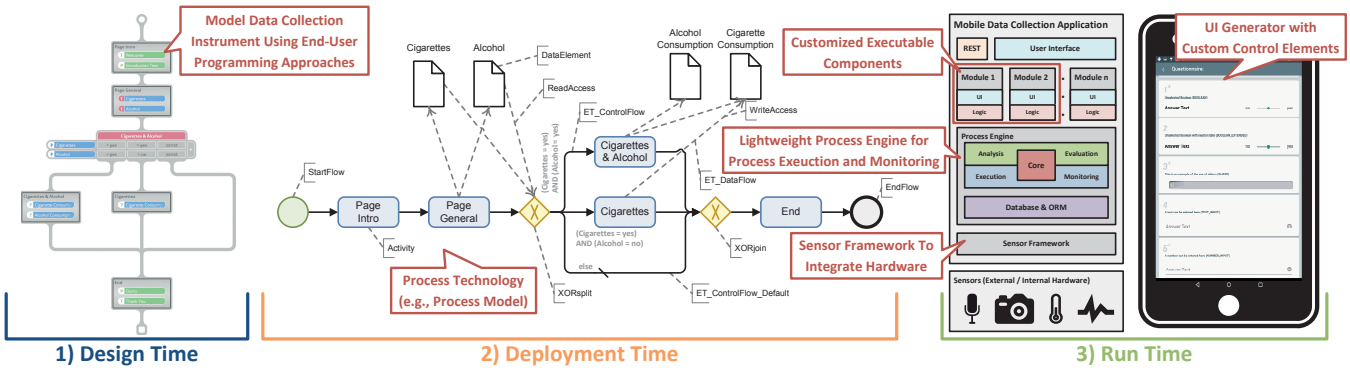

Figure 1. Providing Flexibility in the Lifecycle of Mobile Data Collection Applications

sensors) as well as the corresponding UI is realized using *executable components*. The *Execution* module of the process engine dynamically loads the components needed in order to adjust functionality depending on the application scenario during run time. Second, an advanced UI generator combines all UI fragments created by the executable components and displays them to the user. In particular, platform-specific guidelines needed to be considered as well. Furthermore, custom control elements must be implemented to meet scenario-specific requirements. Third, a sophisticated sensor framework allows connecting both external and internal sensors (e.g., camera, pulse-measuring devices) with the smart mobile application.

The combined use of the various technologies enables flexibility for all phases of mobile data collection applications (cf. Table I). More specifically, they foster the continuous development of mobile data collection applications as new releases can be easily created by domain experts themselves without the involvement of IT experts.

III. Related Work

An approach supporting researchers in collecting data with smart mobile devices is presented in [2]. The platform, however, is specifically tailored to mental health research and cannot be simply adjusted to other domains. Despite useful features, like interval-based questionnaires, the approach does not allow for an automatic UI generation, which is indispensable for any flexible approach. Another framework for mobile data collection is presented in [3]. It provides a limited configurator component allowing users to create data collection applications. This approach, however, lacks flexibility concerning user navigation and sensor integration.

	End-User Programming	Process Model	Process Engine	Executable Components	Sensor Framework
Model-Based Approach	●	●			
Complex Navigation	●	●	●	●	
Different Releases	●	●			
Flexible Execution		●	●	●	
Monitoring & Analysis		●	●	●	
Sensors	●				●
Multilingualism	●			●	
UI Generator				●	
Evolution	●	●	●	●	●

Table I
Combined Techniques Enabling Flexibility

IV. Summary and Outlook

Smart mobile devices offer promising perspectives for collecting high quality data in healthcare scenarios. In particular, domain experts shall be empowered to create mobile data collection applications themselves. This paper introduced a framework, providing flexibility along different phases of the lifecycle of mobile data collection applications. The proof-of-concept prototypes indicate promising results combining end-user programming with process management technology to enhance flexibility in mobile data collection applications. Still further research is needed to foster usability of the developed components. Therefore, a study is planned to evaluate the approach as well as to measure mental efforts spent when designing such mobile data collection applications. Finally, techniques providing flexibility for other phases of the lifecycle (e.g., evaluation of the data collected) need to be introduced and evaluated.

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